Improved BMPs for Storm Water Runoff

0817 Pollution Abatement Ashore Program

May 2004

Technical POC
NFESC, Code 421
Phone 805 982-1302

Management POC
NFESC, Code 45
Phone 805 982-1294

Objective & Navy EQ Requirements

Objective: Enhance the management of storm water runoff from industrial areas to reduce cost and address Navy unique requirements

Requirements	Priority	Requirement Title
2.II.01.k	High	Control/Treat Non-point Source Discharges
2.II.02.c	Medium	Non-point Source discharge Identification
2.II.02.b	Medium	Improved field analytical sensors, assays, methods and protocols

Problem Statement/Drivers (Original)

- Clean Water Act and NPDES discharge regulations
- Cost and NOV avoidance
- Common COTS technology is expensive (> $57K per acre of drainage area)

Problem Statement/Drivers (Current)

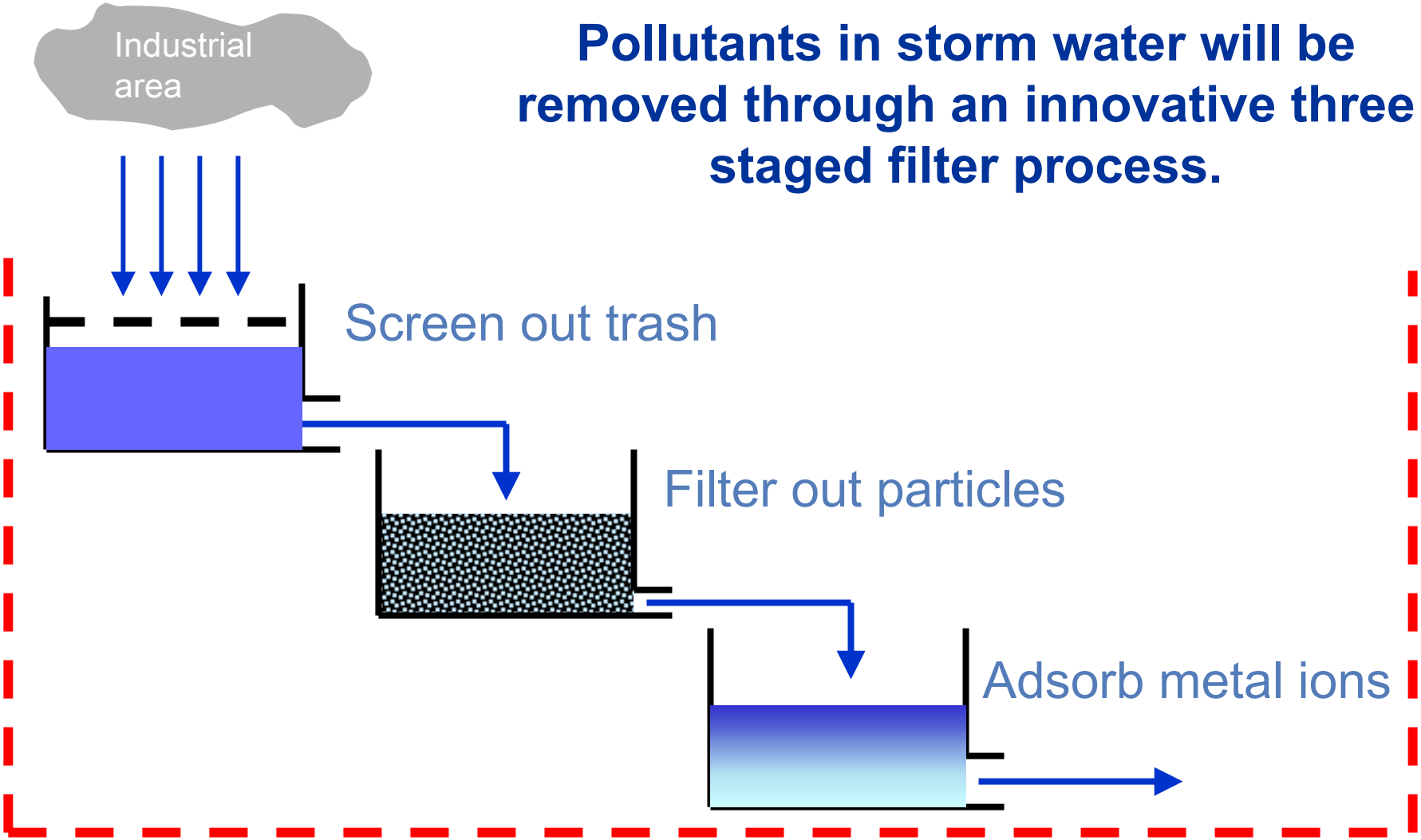
- California Regional Water Quality Control Board – San Diego Region order requires Navy SW discharges from industrial areas to pass bioassay (toxicity) test
- Compliance with the CRWQCB order will require a significant investment by the Navy
- Common COTS technology does not reliably pass toxicity test.

Approach

- Develop a web site to inform Navy storm water managers of best management practices (completed)
- Identify Navy specific requirements for BMPs (completed)
- Test and evaluate most promising BMPs (in progress)
- Demonstrate selected BMPs (in progress)
- Prepare technology transition material (not started)

Success will be measured by demonstrating a low cost technology that will permit the Navy in San Diego to pass a 96 hr-50% LC toxicity test

Technology Description



Before/After Comparison

Before	After
Navy often discharges excessive amounts of metals in storm water runoff in violation of CRWQCB order R9-2002-0169	Navy in compliance with R9-2002-0169
Navy required to build costly runoff storage structures and pay for haul-away or off-site treatment	Treatment structures cost less than storage structures and haul away
Valuable water-side real estate occupied by storm water storage or treatment structures.	Below grade treatment structures preserve valuable water-side space

Benefits: ROI Calculation

Case 1 Treatment versus Collection and Haul-away at NRRC

Item	Collect and haul away	Treatment trench
Capital Costs		
RDT&E	0	100
design	50	70
construction	26.08	36
total	76.08	206
Annual Costs		
contract disposal @ 0.03$/lb	85	5
media replacement	0	4
total	85	9
Annualized capital cost @ 4%, 10 yrs	9.4	25.0
Total annual cost	94.4	34.0
PW of savings (4%, 10 Yr)		489.8
Savings/investment ratio		2.4

Benefits: ROI Calculation

Case 2 Application of Treatment Trench at 3 Shipyards and 3 Recycling Centers

Item	Treatment trench
Capital Costs	
RDT&E	100
design	180
construction	402
total	682
Annual Costs	
contract disposal @ 0.03$/lb	30
media replacement	24
total	54
Annualized capital cost @ 4%, 10 yrs	83
Total annual cost	137
	3364
Savings/R&D Investment	34

Milestones and Major Deliverables of Task

MILESTONE	FY02				FY03				FY04				FY05			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Review BMPs																
2. Identify Navy specific BMPs																
3. Select promising BMPs for T&E																
4. BMP T&E																
5. Develop web based expert system																
6. Prepare final report / implementation plan																

Project Coordination

- **NFESC is working closely with:**
  - **Commander Navy Region Southwest (Rob Chichester)**
    - Storm water runoff policy and regulation. Rob is our interface with the CRWQCB
  - **Engineering Field Division Southwest (Robert Campbell, PE)**
    - Design consultation and Installation support
  - **Naval Regional Recycling Center San Diego (Leslie McLaughlin)**
    - Site of field demonstrations
  - **StormWater Management, Inc. (Daniel Scarpine, PE)**
    - Technical support for StormWater Management, Inc. products

Technical Accomplishments to Date (MS #5)

Developed and published web-based storm water BMP decision support system.

Site address is:

http://enviro.nfesc.navy.mil/stormwaterbmp/

Site provides information on:

140 non-structural BMPs

20 structural (treatment) BMPs

Rules and regulations

Hydrology

Glossary of terms

Links to other sites

- 1734 hits between 1/1/04 and 3/23/04
- 83 unique visitors
- Used in SWPPP training

Technical Accomplishments to Date (MS #5)

An unsolicited e-mail:

Kudos to the Storm water BMP design Team. Great job. Love the new web site. Very useful. Thanks.

Cornelia A. Mueller

Environmental Scientist

Naval Station Newport

Technical Accomplishments to Date (MS #4)

Developed improved adsorption materials to remove copper and zinc from storm water runoff at Navy activities in San Diego.

Driver:

Order R9-2002-0169 of the California Regional Water Quality Control Board, San Diego Region, directs the Navy to:

- **Terminate the first ¼ inch of storm water runoff from each storm,**
- **Pass a 96-hour bioassay (toxicity) test using undiluted storm water,**
- **Make significant efforts to reduce copper concentrations in storm water discharges to less than 63.6 micrograms/liter, and**
- **Make significant efforts to reduce zinc concentrations in storm water discharges to less than 117 micrograms/liter.**

Technical Accomplishments to Date (MS #4)

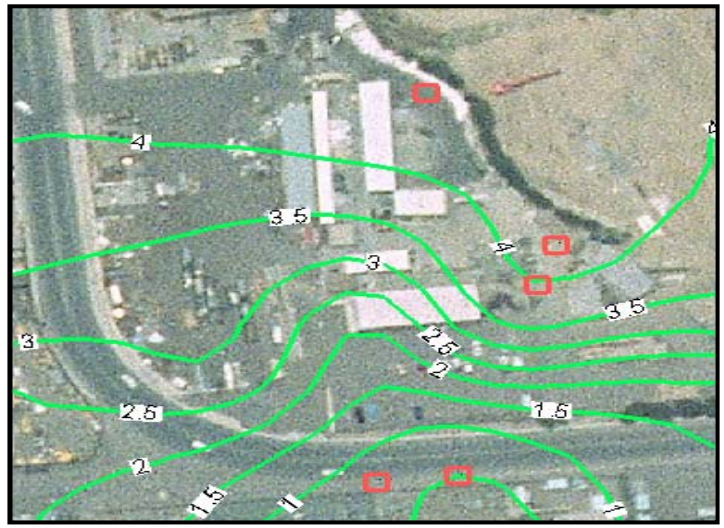
Naval Regional Recycling Center San Diego

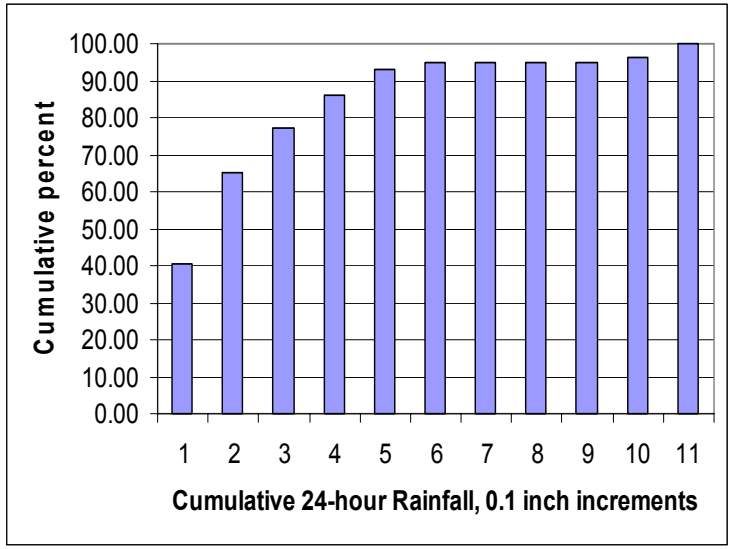
90% of rain falls in storms of less than 0.5 inch

Average storm duration is 3 hours

Maximum runoff flow is 0.56 cfs

Average runoff volume is 5600 cubic feet (42,000 gallons)





Technical Accomplishments to Date (MS #4)

An artificial rain event at NRRC

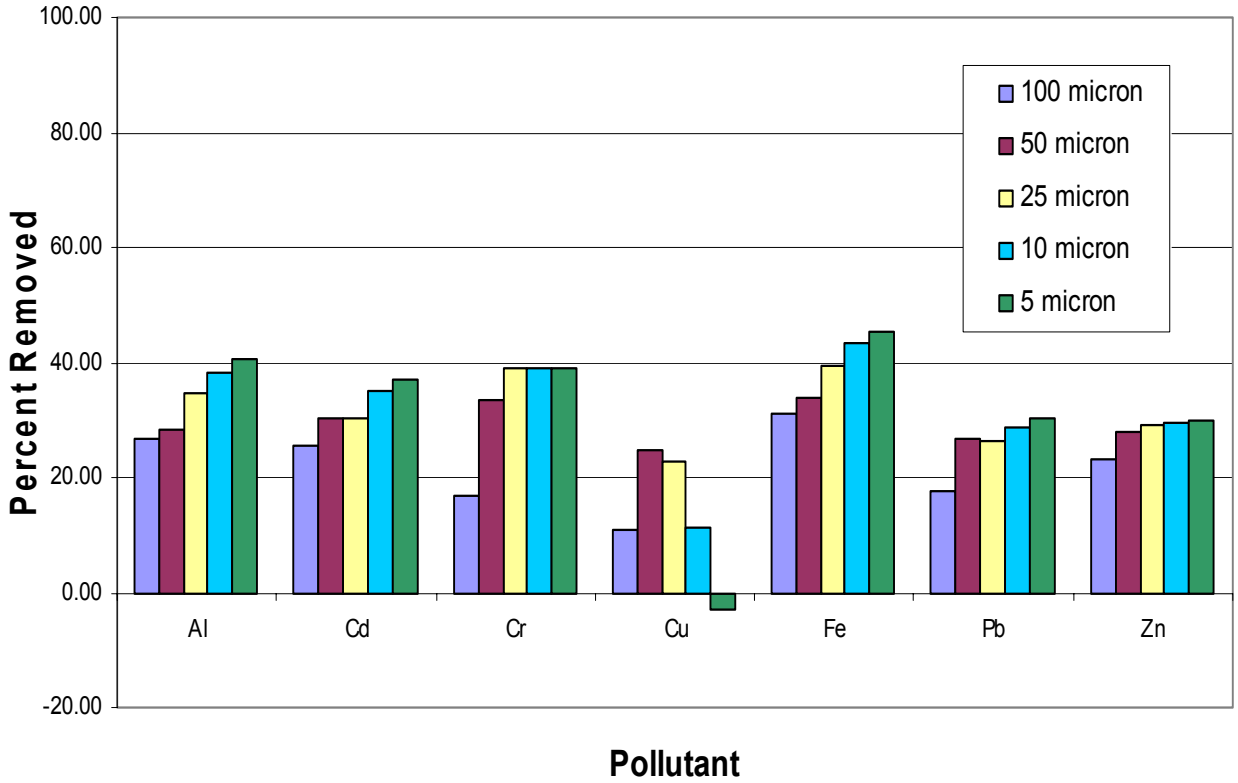
Technical Accomplishments to Date (MS #4)

Analysis of runoff from NRRC

Metal	Concentration in Storm Water, µg/L	Concentration in Fire Hydrant Water, µg/L	Multi-Sector Permit Requirement, µg/L
Antimony	138	7	
Arsenic	18	ND	168
Beryllium	ND	ND	
Cadmium	136	ND	15.9
Chromium	102	ND	
Copper	3,350	5	64
Lead	1,200	5	82
Mercury	ND	ND	2.4
Nickel	245	ND	1417
Selenium	14	6	238
Silver	4	ND	32
Thallium	ND	ND	
Zinc	6,860	169	117
Aluminum	19,900	9	750

Technical Accomplishments to Date (MS #4)

Results of filtration tests



Filtration through a 0.45 micron filter indicates that about 50% of the copper and about 15% of zinc are in ionic form

Technical Accomplishments to Date (MS #4)

Treatment media test stands

Tanks hold runoff water from NRRC; cylinders contain filter/adsorption media

Technical Accomplishments to Date (MS #4)

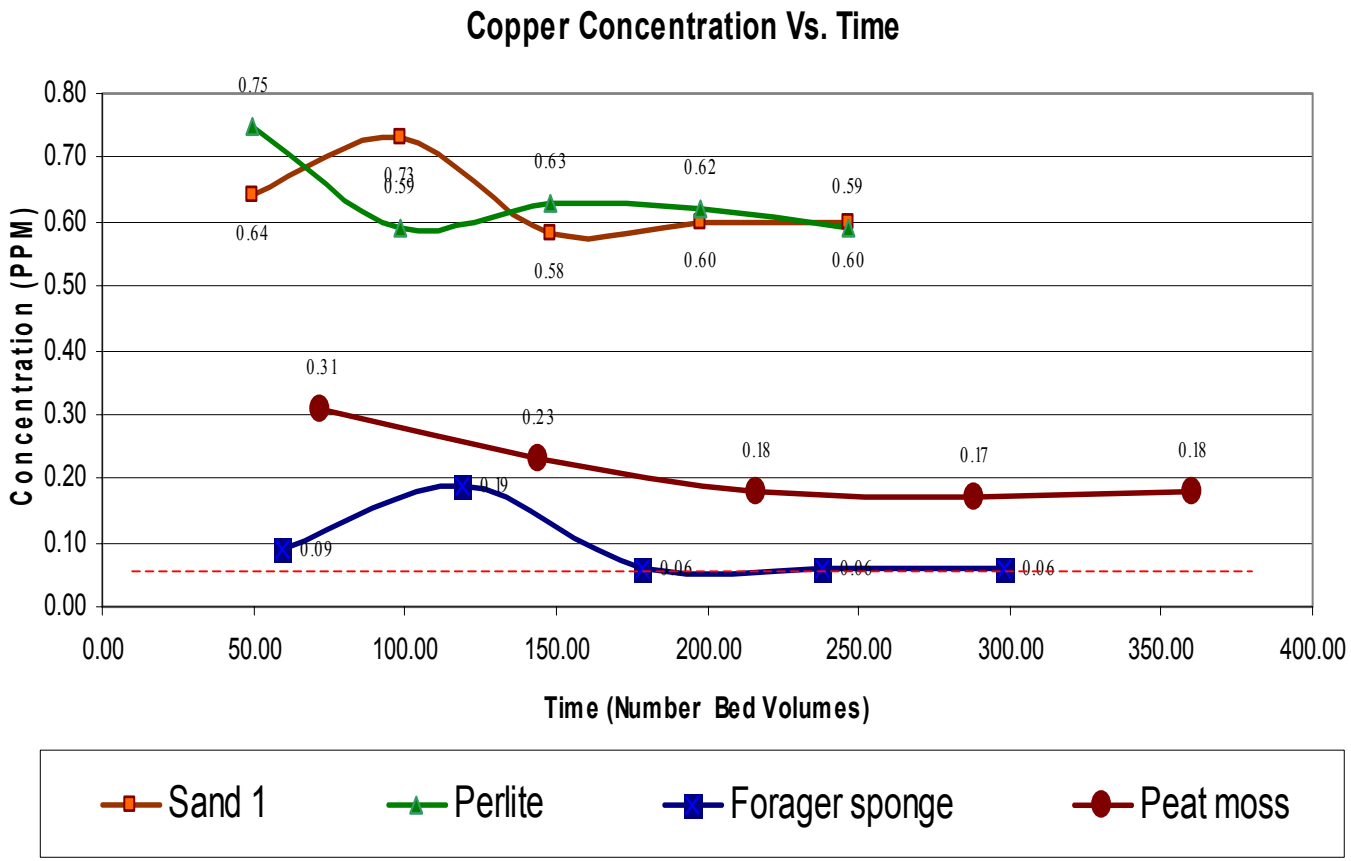
Twenty four filter and adsorption materials were tested

Organic materials	Active minerals	Inert minerals	Proprietary materials	Other
Loose peat moss	A-400 activated alumina	Perlite	Forager sponge cubes	Iron chips and filings
Hardwood chips	FS-50 activated alumina	Washed plaster's sand	Dynaphore granules	Sodium alginate beads
Bone char	DD-2 activated alumina	Washed concrete sand	Ancor M-20/80 zero valence iron	geotextile
Anthracite	Chabasite	Washed well-packing gravel	Stormwater Management Metal Rx	
Crumb rubber	Glauconite		Environmental H20, LLC White Karbon	
Sulphonated peat moss	Ilmanite			
	Manganese green sand			

Technical Accomplishments to Date (MS #4)

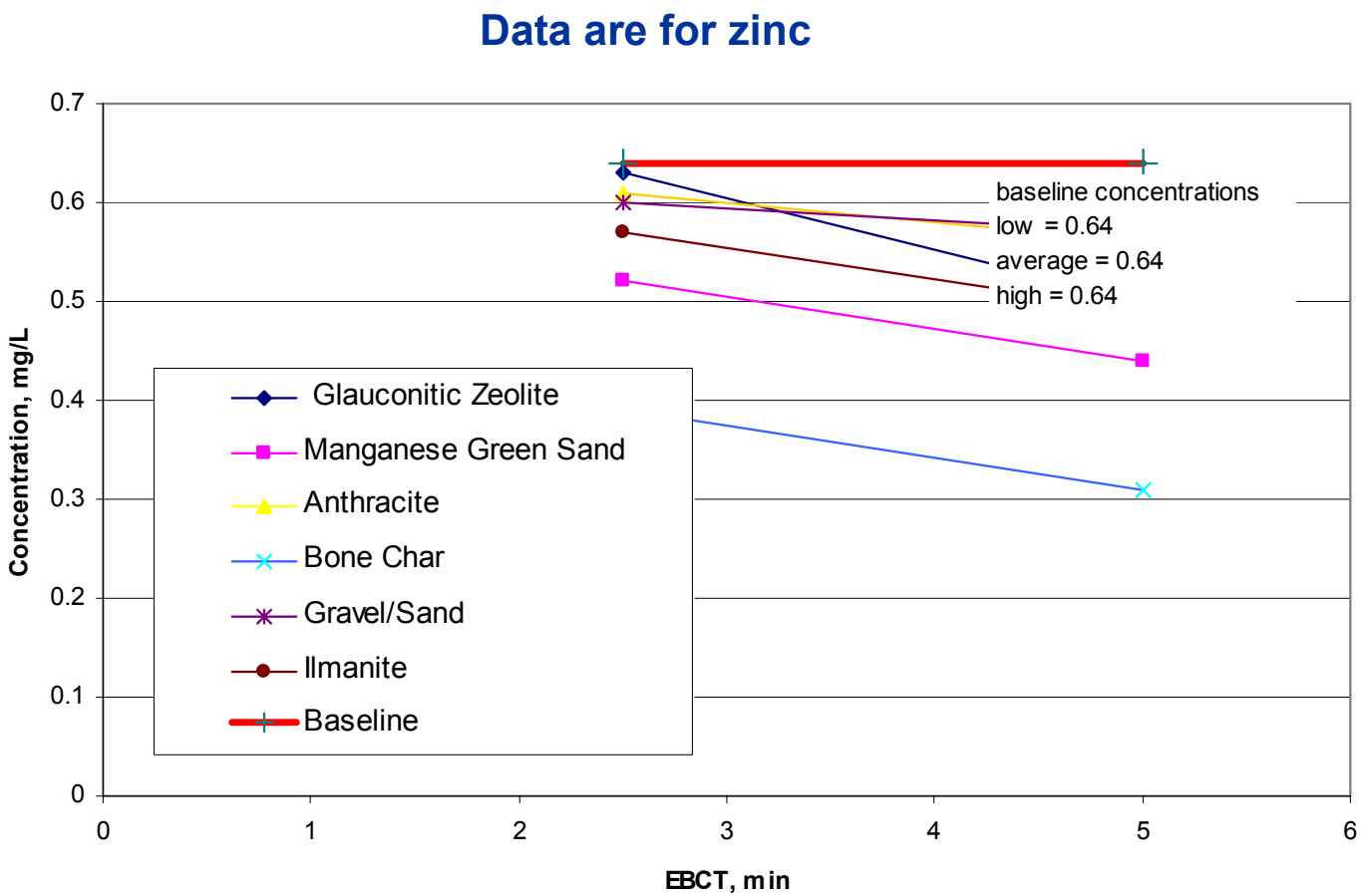
Typical experimental results

Baseline Cu concentration is 1.8 mg/l



Technical Accomplishments to Date (MS #4)

Experimental results – EBCT sensitivity study



Technical Accomplishments to Date (MS #4)

Results of tests of combinations of media

Concentrations are in micrograms/L

Test BF-1		
Metal	In	Out
Al	420	ND
Cd	18	ND
Cr	ND	ND
Cu	500	69
Fe	1700	160
Pb	17	ND
Zn	300	111

Test DC2-20		
Metal	In	Out
Al	74	123
Cd	26	ND
Cr	ND	ND
Cu	667	ND
Fe	145	88
Pb	ND	ND
Zn	609	ND

Technical Accomplishments to Date (MS #4)

Results of tests of combinations of media

Concentrations are in micrograms/L

Metal	Combination A	Combination B	Combination C	Combination D	Detection limit
Aluminum	2.55	0.453	0.08	0.123	0.04
Cadmium	0.008	0.009	0.026	ND	0.008
Chromium	ND	ND	ND	ND	0.008
Copper	ND	0.046	0.729	ND	0.012
Iron	0.211	0.33	0.155	0.088	0.008
Lead	ND	ND	ND	ND	0.014
Zinc	0.02	0.654	0.654	ND	0.01

Technical Accomplishments to Date (MS #4)

Storm water treatment technology test stand

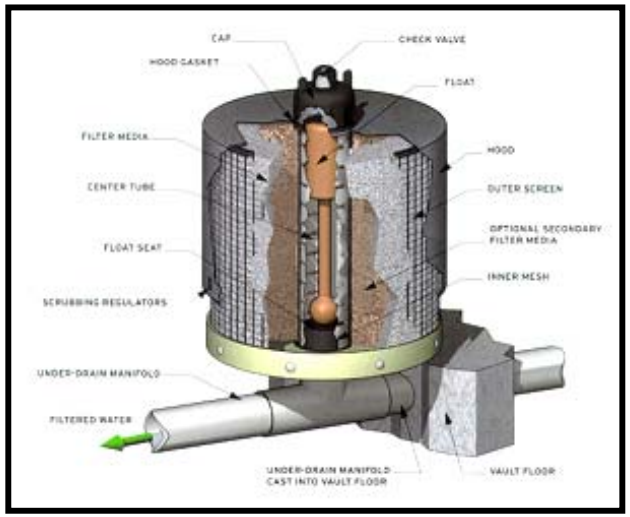
Test stand automatically collects, samples, and treats storm water.
Self contained unit needs no external power supply or manual input.

Technical Accomplishments to Date (MS #4)

Large scale StormWater Management, Inc. Installation

This 165 cartridge SMI installation at NASSCO costs $530K

System has passed the toxicity test only 33 % of the time



Technical Accomplishments to Date (MS #4)

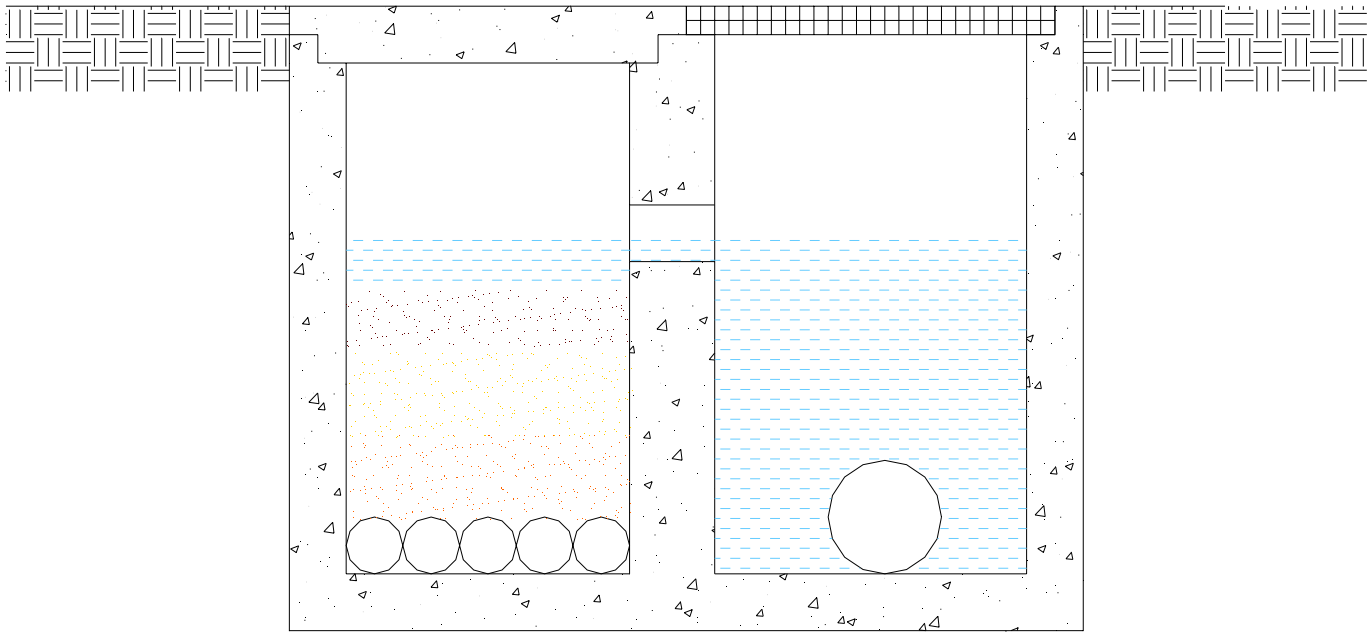
Typical results for SMI StormFilter technology

	Copper			Zinc		
Laboratory	[C] in, µg/l	[C] out, µg/l	% reduction	[C] in, µg/l	[C] out, µg/l	% reduction
SMI	866	349	60	1190	185	84
NFESC	840	310	63	430	170	60
Storm #1	240	85	65	380	120	68
Storm #2	212	90	58	410	100	76
Storm #3	502	229	54	980	200	80

Technical Accomplishments to Date

Dem/Val Option A: Modified Delaware sand filter

Dem/Val at NRRC funded by ESTCP. Construction scheduled for Q1, FY05

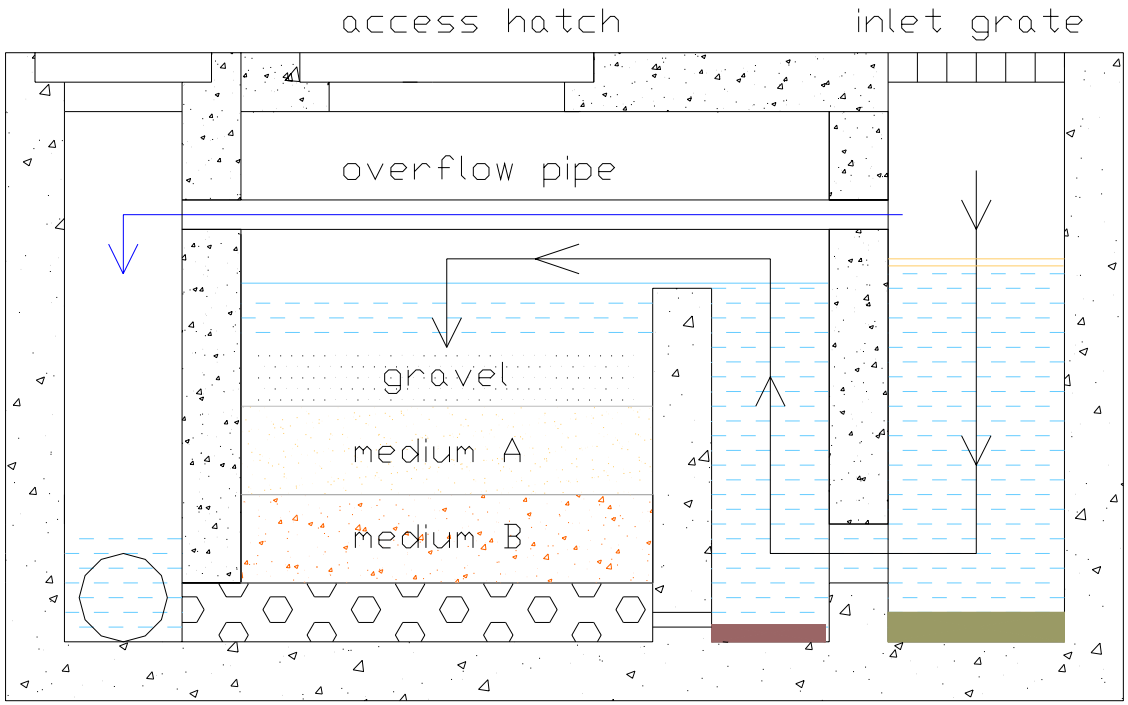


Cross-section of treatment trench

Technical Accomplishments to Date

Dem/Val Option B: Sand filter with improved pre-treatment

Dem/Val at NRRC funded by ESTCP. Construction scheduled for Q1, FY05



Cross section of treatment trench

Implementation Accomplishments and Plan

Accomplishments: Successful ESTCP proposal for structural BMP demonstration.

Plan: Technology transition will be accomplished by the ESTCP

NFESC has partnered with the Aberdeen Test Center to prepare technology transfer material that can be used service wide.

Logic Model for Improved BMPs for Storm Water Runoff

Navy Benefits	Navy will have technology to allow them to be in compliance with SW discharge regulations
Customer Capability	Navy can treat SW to remove toxic metals to very low concentrations
Products	Material specifications, commercial license agreements, design guidance, system sizing software
Project Milestones	MS 4 (Q3,FY04). BMP T&E must be completed in a timely manner if ESTCP project is to benefit.

Summary

“ When will the final report for the test stand be completed? I want to take that report to the regulators and try to get their agreement that this will suffice for 1/4" diversion at this location. “

Rob Chichester
Water Compliance Manager
Commander Naval Region Southwest

E-mail to NFESC of 18 March 2004

There is a high level of interest in this project in San Diego. All of the stakeholders are interested in seeing this project succeed. Support by CNRSW, NRRC, and EFDSW has been outstanding.

Summary

- Completed BMP web site
- Developed improved filter/adsorption materials for removing toxic metals from storm water.
- Designed built automated storm water treatment technology test stand.
- Developed field performance data on storm water treatment technologies.